ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

A Unified Fuzzy Control Strategy used in Distributed Generation For the 3- φ Inverter

[1] M.sivaganga, [2] P. Raja sekhar
[1] PG Scholar, [2] Academic Assistant
[1] [2] Dept. of EEE, JNTU Pulivendula, Andhra Pradesh India.

Abstract— This paper is representation a unified controller stratagem intended for DG during equally grid tied and island modes. The current references generation part module is analyzed a unified controller stratagem in both modes. The proposed controller strategies compose of a novel, voltage loop with an inner inductor, current loop within the synchronous reference frames. The module elements preserve analyze through two aspects. Primary, through introducing P compensator with Q-axis furthermore PI compensator with D-axis correspondingly, an internal inductor current loop controller is activating in the grid tied mode and preserve be mechanically inactivated upon occurrences of island. Thus, for the detection of uncertain islanding or two different controllers modes there is no want for two switches and change from the grid tied mode toward the island mode, the load voltage worth is able to enhance. The module next part is to nearby the load current, feed forward in direction of compact with the problem caused through the non-linear local load, in these, not only the waveform of the grid current inside grid tied is enhanced, but also the worth of the loaded voltage inside the island mode is enhanced. In conclusion the effectiveness of the propose controller stratagem and fuzzy control are validated through the simulation results.

keywords—3- φ inverter, Islanding mode, Distribution generation {DG}, seamless transfer, unified control, load current.

INTRODUCTION

while nonconventional energy or renewable resources are existing , like fuel cells, wind turbines, photovoltaic arrays, and micro turbines, distribution generation [DG] is budding when a practical alternative. For the interfacing purpose, use the power electronics devices like 3- φ inverter in between renewable resources and utility. Furthermore, DG is a suitable form to propose high consistent electrical power supplies since it is capable near operates either in the island or grid-tied mode. In the grid operation, DG is delivery the electrical power toward the local vital load and the utility. Upon the island is form due to the happening of utility outages. In this circumstance, the DG must be tripped and finish to boost the portion of utility after possible. Though, toward improved the electrical power reliability of some local vital load, the utility can be detach by DG be supposed to and keep on supplying the local vital load the grid tied operation by the DG and utility contained by the island modes are set the load voltage in both operation modes also, since it is the major issues of both operational modes. Hence, while the islanding state detected, DG has to take voltage more quickly as than the loaded voltage feasible, during sort to decrease the transient within the loaded voltage. Moreover this problem brings challenge intended with DG operation. Droop-based control is called like control of voltage mode during this paper, and it be capable of also be applied toward DG to take in the power distribution between the grid tied mode by utility and DG [1]–[4]. During this condition, the loop of voltage is consider in the inverter also it is always regulated while a source of voltage and the loaded voltage worth is maintain be assured in the transition of operation modes but the dynamic presentation be poor, while the bandwidth of the external power loop, realizing droop control, be a lot lesser than the loop of voltage. Furthermore, the current of grid is not controlled straight, and the concern of the inrush grid current always exists for the duration of the transition from the islanded near the grid tied mode, still while virtual inductance and [PLL], phase locked loop are adopted [3]. DG engaged with two distinct controllers sets are [5]–[15] , i.e. the one sets of controller is the inverter controlled as a voltage source in the islanded mode, while with other controller sets as source of current in the grid tied mode. As a result of these that is either the current loop or voltage loop is currently utilized in this approach can get a good dynamic performance. Further within the grid tied mode, the current of output is straightforwardly controlled and the inrush grid current be approximately eliminate. When DG operation modes are altered then we had toward switching the controllers. Switch the voltage control mode, in the interval as of the happening of utilities outages and the load ing voltage is not fix through the both, DG and the island and utility finding method is done with the time instance interval length so, the major subject during this advance be makes the worth of the loading voltage be a great deal subject about the speed in an addition in the direction of precision of the islanded finding process. One more subject connected with the aforementioned approaches is the waveform excellence of the grid -tied current and the loading voltage within nonlinear local load. If you get pure sinusoidal the output current of DG through the grid mode is

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

[5]. The utility has the harmonic load current component, while the non -linear local load is feed. For justifying reason the single-phase DG be present injects the harmonic current taken with the utility in grid current mode [6]. controlling the DG just before follow a resistance by the harmonic frequency thus the voltage- mode control is improved, moreover then the harmonic current fluid keen on utility can be mitigate .The load voltage may be distort contained by the island mode as the non -linear load fed[11]. For the improvement of the load voltage worth a lot of control schemes have been proposed, with a multi loop control schemes [11]–[13] ,sliding mode control [15], resonant controllers [14]and Though, the nonlinear local load within DG trade by way of accessible control strategies, mostly focus going on either the worth of current of the grid throughout the grid mode otherwise the single of the loading voltage contained by the island mode, but by using a unified controller strategy in DG, improve two of them is seldom.

A unified controller stratagem is containing main two parts, which are proposed inside this paper. Primary part is [SRF], in DG gives references for the 3- φ inverter is employ conventional loop of inductor current control acts like a source of current also aforesaid shortcoming are avoids. Next part is supply reference used for the current loop of inner inductor toward exist by a voltage controller, wherever a proportional [P] along with a proportional-plus-integral [PI] compensators are employs in and Q-axis and D-axis. The utility is subject the loading voltage for the duration of the grid operation compensator on D axis is saturated, as using the PLL the output voltage compensator on Q axis is force towards zero. The DG is control like a source of current due to the loop of inner current hence, loop of the voltage cannot regulate in loop of the inner current references. When the grid outage occurred, the utility further not determine the load voltage, and the voltage controller is activate the load voltage by mechanically. Therefore a forced switching does not require stuck between two different controllers sets in proposed control stratagem. More, there is no requiring detecting the islanding accurately and quickly, and in this approach detection of the islanding is easy. Besides, the propose controller strategy endows a better dynamic presentation, compare toward the voltage mode controller by from just using the voltage and current feedback controller. In third approach is introduce a united loading current supply forward, it improve the operation of the propose controller stratagem, in the occurrence of the non-linear local load. This scheme is implement in the references of the inner current through add the loading current inside loop. The harmonic components of the grid currents force be mitigate in the grid mode, because of the DG inject harmonic currents hooked on the grid mode. Furthermore to improve quality of the loading voltage, for these proposed loading current feed forward be able to is considering in both operation modes. This paper is approved like follows. Part II explain the controller diagram and power stages in DG for 3- φ inverter by the proposed unified control strategy. Part III explains the propose controller strategy in DG and the operation principles. Part IV explains the parameter proposes and the propose controller system with small signal study. Part V investigates the propose controller strategy simulation result and lastly, part- VI explains the concluding remarks.

II. UNIFIED PROPOSE CONTROLLER STRATEGY

A. DG Power Stages

Design and analysis a unified controller strategy in both modes, island and grid modes for a 3- φ inverter into DG presents inside this paper. Fig.1 representation by the propose controller strategy of DG. The DG, distribution generation is set with a 3- φ interface inverter done by a L-C filter. The primary input energy is converting into the electrical energy, using the front end power converter which is after that converting toward dc and it regulated output dc voltage. So, it be capable of being represent with the dc voltage source, Vdc in Fig. 1 and the inverter ac side, the local critical- load is associated directly.

In Fig. 1, contains switches are Si, Su and their functioning are unlike. The DG is control the inverter switch Si, and be the switch Su, governs the utility.

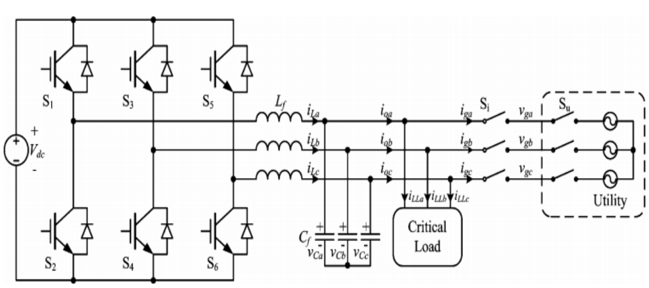


Fig 1. DG control diagram based on the propose controller strategy

IFERP connecting engineers... developing research

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

As soon as the quantity of utility is normal, the both switches are Su and Si, ON and the distribution generation [DG] into the grid mode injects powers inside the direction of the utility. The utility is tripped, the utility switch Su instantly when the fault on utility condition and then the island is conform. The inverter is control like a source of current toward generates the references power P_{DG}+j Q_{DG} within the grid mode. Output power P_{DG} +j Q_{DG} is equal to the sum of the power inject to the grid mode Pg + jQg and the load demand Pload + jQload in this condition let the load is represented like a parallel R-L-C circuit.

$$P_{\text{load}} = \frac{3}{2} \cdot \frac{V_m^2}{R} \quad (1)$$

$$Q_{\text{load}} = \frac{3}{2} \cdot V_m^2 \cdot \left(\frac{1}{\omega L} - \omega C \right). \quad (2)$$

If Qg and Pg are positive in the grid mode and inject in the grid then after the island happenning Qload and Pload will be increase and the frequency and magnitude of the loading voltage will be increase and drop, correspondingly. When the output power of inverter PDG + jQDG could be synchronized near match the load demand by changing the current references previous to the island is confirm, the loading voltage outages will be mitigat.

Fig. 2 explains the propose unified controller stratagem on the whole block diagram, wherever the utility voltage vgabc, the loading current iLLabc,, the load voltage Vcabc, and the inductor current ILabc, are sensed. The current reference generation module, the PLL and the loop of inductor current, are mainly composed in this control diagram.

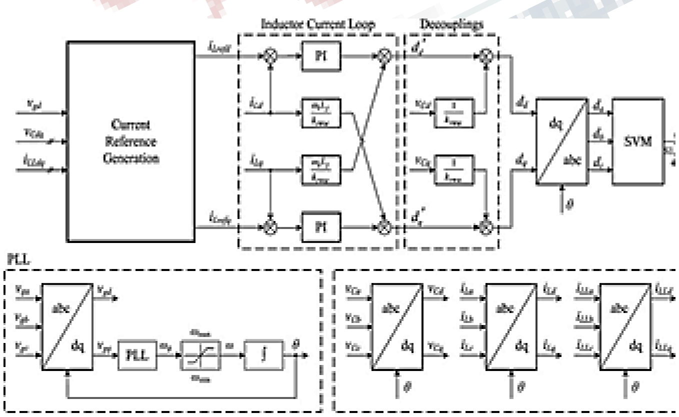


Fig.-2. Control block diagram of the propose unified controller strategy.

Stranded on the SRF (PLL), exist the PLL in the propose controller stratagem, toward estimate the utility phase and the frequency in the 3- φ power converter by SRF (PLL), generally. Using the current references Irefdq to regulate the inductor current, and the grid mode voltage VGabc is coordinate the phase of current.

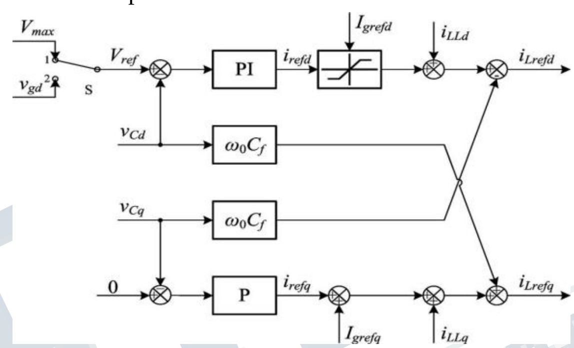


Fig 3 shows the current reference generation unit Schematic diagram.

Fig. 3, shown, provides the current reference design for the loop of inner current within two, island and grid modes through the propose current reference generation component. Tables for control strategy, parameters values:

TABLE-1

Parameters	Value
DC voltage V_{dc}	400 V
Filter inductor L_f	3.5 mH
Filter capacitor C_f	15 μF
Switching frequency f_s	10 kHz
Sampling frequency f_{smp}	20 kHz
Rated power of DG P_{DG}	3000 W
Rated RMS phase voltage V_n	115 V
Rated utility angle frequency ω_0	50×2π rad/s
Rated linear local load R_{load_ac}	60 Ω
Rated nonlinear local load R_{load_dc}	120 Ω

TABLE-2

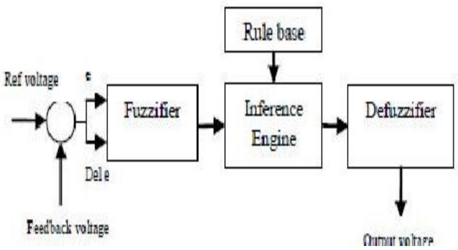
Parameters	Value
Voltage reference V_{max}	179 V
Rated current reference I_{grefd}	9 A
Rated current reference I_{grefq}	0 A
Upper value of the limiter ω_{max}	50.2×2π rad/s
Lower value of the limiter ω_{min}	49.8×2π rad/s

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

A. FUZZY LOGIC CONTROLLER

Fuzzy logic Controller organization is represents in below. The function of every block is the follow:



The DC bus voltage error value Δvdc= v* −v is conceded throughout a Fuzzy controller compensator near regulating the dc bus voltage, vdc by a set value. The process of FLC is like so. Three basic parts are in FLC:

(i) Fuzzification(ii) Base rule (iii) the De-fuzzification. FLC has two near inputs they are: the change in error and error, and one output value.For the fuzzy controller the Membership functions with Mamdani method is used as follows.

Fuzzy controller based rules

ΔE \ E	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NM	NM	NS	ZE	PS
NS	NB	NM	NS	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PS	PM	PB
PM	NS	ZE	PS	PM	PM	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

III. DG, Modes Operational principles.

1). Operation of Grid-Tied Mode:

Express a park transformation by (3), the PLL gives the voltage of utility phase angle with a limiter, an integrator and a PI compensator.

The i_{Lrefdq} , the loop of inductor current orientation is complexly and it is explain below. The utility can be expressed as (5) in d-q axis.

$$i_{Lrefd} = I_{grefd} + i_{LLd} - \omega_0 C_f \cdot v_{Cq}. \qquad (6)$$

$$i_{Lrefq} = v_{Cq} \cdot k_{Gvq} + I_{grefq} + i_{LLq} + \omega_0 C_f \cdot v_{Cd} \qquad (7)$$

Fig.4 be capable of clarify the loop of inductor current control for the3- ɸ inverter , by used the inductor current reference being gritty via the loading current i_{LLdq} and the current references igref dq in grid mode, the inverter being controlled like a current source.

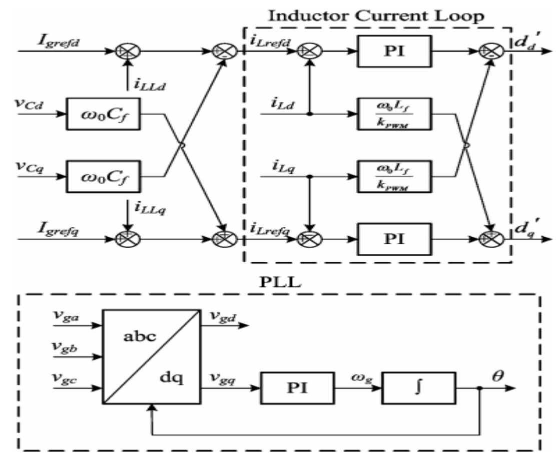


Fig. 4. Simplified block diagram of the unified control strategy when DG operates in the grid-tied mode.

2). change from the Grid tied Mode toward the Islanded Mode:

Fig. 5, the island is confirmed, the primary time of interval is since the instating of turn off Su toward the instant of turn off Si. The next time interval begins from the instating of turn off inverter switch Si.

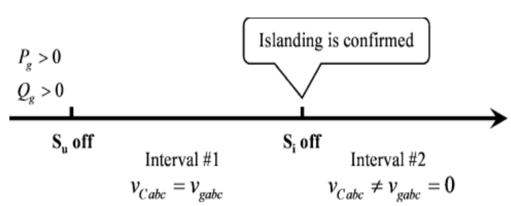


Fig. 5. Operation sequence during the transition from the grid-tied mode to the islanded mode.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

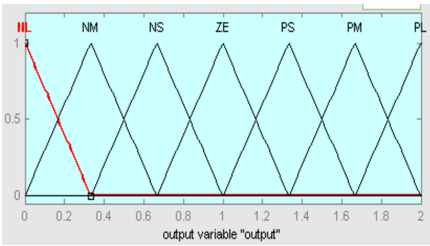


Fig. 6 explain the dynamic processing through this time interval

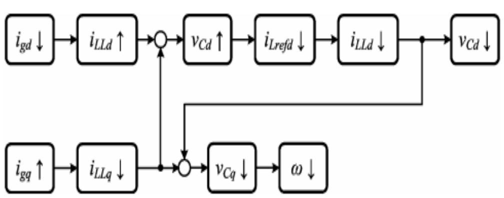


Fig. 6. Transient process of the voltage and current when the islanding happens.

$$P_g = \frac{3}{2} \cdot (v_{Cd} i_{gd} + v_{Cq} i_{gq}) = \frac{3}{2} v_{Cd} i_{gd} \quad (8)$$

$$Q_g = \frac{3}{2} \cdot (v_{Cq} i_{gd} - v_{Cd} i_{gq}) = -\frac{3}{2} v_{Cd} i_{gq} \quad (9)$$

$$\begin{aligned} Z_{\text{sload}} &= R_s + j\omega L_s + \frac{1}{j\omega C_s} \\ &= R_s + j\left(\omega L_s - \frac{1}{\omega C_s}\right) \\ &= R_s + jX_s. \end{aligned} \quad (10)$$

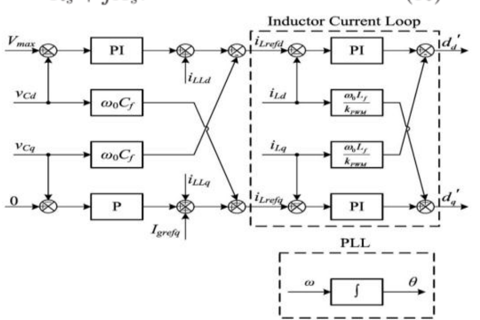


Fig. 7. Simplified block diagram of the unified control strategy when DG operates in the islanded mode.

$$v_{Cd} = i_{LLd} \cdot R_s - i_{LLq} \cdot X_s \quad (11)$$

$$v_{Cq} = i_{LLq} \cdot R_s + i_{LLd} \cdot X_s. \quad (12)$$

3) The Island Mode:

Both the switches Si and S_u are in the OFF state during the island mode,. Fig. 7 explains the3- φ inverter control diagram in the islanded mode.

4). change from the Island to the Grid tied Mode

The Switch Su is ON only once the utility is restored, the utility then be connecting through the DG during turn on switch Si. The PLL will path the utility phase when utility voltage is restored. While a resultant, the loading voltage V_{Cabc} phase angle will track the voltage Vgabc. While the amount of voltage Vmax of the load voltage is larger than the magnitude Vg then toggling the selector switch S as of terminals 1 to 2 once the voltage reference Vref will changed to Vg. Third, the selector S is reset to terminal 1 while the Si is turned on. During in this situation, the loading voltage resolve be held with the utility.

Analysis and design

(1) Steady State(i) Operation Points;

in loop of the inductor current through the compensator PI, the steady state errors resolve be zero so the steady state inductor current in be capable of expressed like follows(13), the relationship stuck between the voltage, the capacitor filter current are shown (14) within steady state in SRF.

$$\begin{cases} i_{Ld} = I_{grefd} - \omega_0 C_f \cdot v_{Cq} + i_{LLd} \\ i_{Lq} = v_{Cq} \cdot k_{Gvq} + \omega_0 C_f \cdot v_{Cd} + I_{grefq} + i_{LLq}. \end{cases} \quad (13)$$

$$\begin{cases} i_{Cd} = -v_{Cq} \cdot \omega C_f \\ i_{Cq} = v_{Cd} \cdot \omega C_f \end{cases} \quad (14)$$

The powers of reactive and active are flowing as of inverter toward utility can be given in Igref d and Igref q , correspondingly.

$$\begin{cases} P_g = \frac{3}{2} \cdot [v_{Cd} (i_{od} - i_{LLd}) + v_{Cq} (i_{oq} - i_{LLq})] \\ \quad = \frac{3}{2} \cdot v_{Cd} I_{gref\,d} \\ Q_g = \frac{3}{2} \cdot [v_{Cq} (i_{od} - i_{LLd}) - v_{cCd} (i_{oq} - i_{LLq})] \\ \quad = -\frac{3}{2} \cdot v_{Cd} I_{grefq}. \end{cases} \quad (17)$$

In Fig.2, where ω_{min} and ω_{max} are represents the lower and upper values of the limiter. Igref determined the angle frequency of the load voltage ω in the islanded mode.

$$\omega = \begin{cases} \omega_{\min}, & I_{grefq} > 0 \\ \omega_{g0}, & I_{grefq} = 0 \\ \omega_{\max}, & I_{grefq} < 0. \end{cases} \quad (22)$$

ii) Selection of Limiters and References

The current reference Igrefd injects the active power Pg into grid in the grid-tied mode. The sort of the normal grid voltage is 0.88–1.1 p.u, so Vmax be able to elected since

$$V_{\max} = 1.1 \cdot \sqrt{2} \cdot V_n \quad (23)$$

2). Transient State

i)the Power Stage in Small-Signal Model

Fig. 1, the dc-link voltage Vdc is regulated with the front-end converter in DG. Average power stage model be able to described

$$\frac{V_{dc}}{2} \cdot \begin{pmatrix} d_a \\ d_b \\ d_c \end{pmatrix} = L_f \cdot \frac{d}{dt} \begin{pmatrix} i_{La} \\ i_{Lb} \\ i_{Lc} \end{pmatrix} + R_l \cdot \begin{pmatrix} i_{La} \\ i_{Lb} \\ i_{Lc} \end{pmatrix} + \begin{pmatrix} v_{Ca} \\ v_{Cb} \\ v_{Cc} \end{pmatrix} \quad (24)$$

$$\begin{pmatrix} i_{La} \\ i_{Lb} \\ i_{Lc} \end{pmatrix} = C_f \cdot \frac{d}{dt} \begin{pmatrix} v_{Ca} \\ v_{Cb} \\ v_{Cc} \end{pmatrix} + \begin{pmatrix} i_{LLa} \\ i_{LLb} \\ i_{LLc} \end{pmatrix} + \begin{pmatrix} i_{ga} \\ i_{gb} \\ i_{gc} \end{pmatrix}. \quad (25)$$

The small-signal model be capable of simplified into two the same SISO systems, which is represented by (28) and the subscripts q and d are ignored

$$\begin{cases} \frac{V_{dc}}{2} \cdot \hat{d} = L_f \cdot \frac{d}{dt}\hat{i}_L + R_l \cdot \hat{i}_L + \hat{v}_C \\ \hat{i}_L = C_f \cdot \frac{d}{dt}\hat{v}_C + \hat{i}_{LL} + \hat{i}_g. \end{cases} \quad (28)$$

ii).Design and Analysis of the inductor Current Loop

The current loop is supposed to operate usually to regulate the loop of inductor current during both island and grid modes.

$$G_{id1}(s) = \frac{\hat{i}_L(s)}{\hat{d}(s)} = \frac{V_{dc}}{2} \cdot \frac{sC_f}{s^2 L_f C_f + sR_l C_f + 1}. \quad (29)$$

$$G_{id2}(s) = \frac{\hat{i}_L(s)}{\hat{d}(s)} = \frac{V_{dc}}{2} \cdot \frac{1}{sL_f + R_l}. \quad (30)$$

The current loop gain is exposed in Fig. 9, by the crossover frequency- 1100 Hz and phase margin -65◦

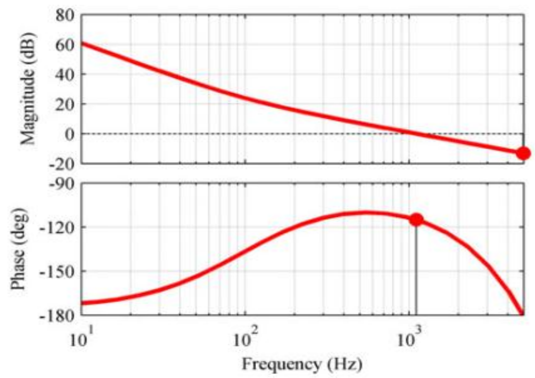


Fig. 9. Bode plot of the loop gain of the inner current loop.

$$G_i(s) = k_{Gi} \cdot \frac{1 + \frac{s}{\omega_{Gi}}}{s}. \quad (31)$$

iii) The Island Voltage Loop analysis with Design

The voltage loop just operates into the island mode to regulates the loading voltage, and the basic block diagram is exposed in Fig. 10

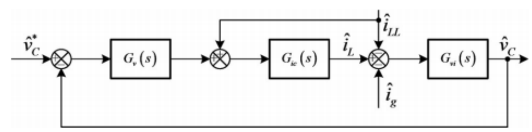
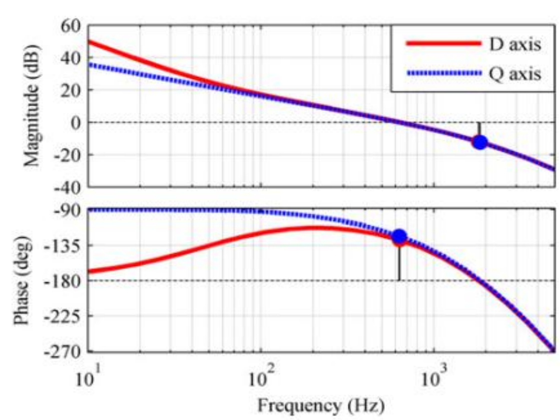


Fig. 10. Block diagram of the simplified voltage loop

During the D-axis, GV D is a PI compensator showing in (32), as a P compensator GV Q expressed in (33) is used within Q-axis.The current loop gain is exposed within Fig 11



.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 9, September 2017

Fig. 11. Bode plot of the loop gain of the voltage loop in D- and Q-axes.

$$G_{vd}(s) = k_{Gvd} \cdot \frac{1 + \frac{s}{\omega_{Gvd}}}{s} \quad (32)$$

$$G_{vq}(s) = k_{Gvq}. \quad (33)$$

iv) Impact of Load Current Feed forward

To estimation the effective of the load current feed forward inside the island mode, the transfer function of the output impedance is consequent.

$$Z_{o1}(s) = \frac{\hat{v}_C(s)}{\hat{i}_{LL}(s)} = -\frac{G_{vi}(s) \cdot [1 - G_{ic}(s)]}{1 + G_v(s) \cdot G_{ic}(s) \cdot G_{vi}(s)} \quad (34)$$

$$Z_{o2}(s) = \frac{\hat{v}_C(s)}{\hat{i}_{LL}(s)} = -\frac{G_{vi}(s)}{1 + G_v(s) \cdot G_{ic}(s) \cdot G_{vi}(s)}. \quad (35)$$

The Bode -plot for stability of the output impedance of these both conditions is exposed in Fig. 12, and it be able to seen that the amplitude of the output impedances is reduced from dc to 600 Hz through the load current feed forward.

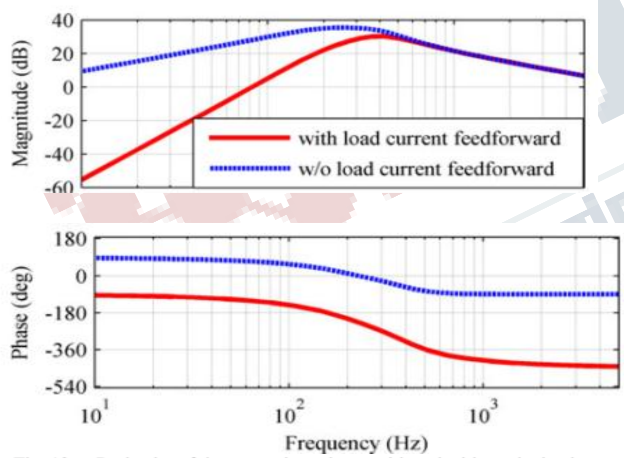


Fig. 12. Bode plot of the output impedance with and without the load current feedforward, when DG operates in the islanded mode.

Fuzzy controller Simulation results

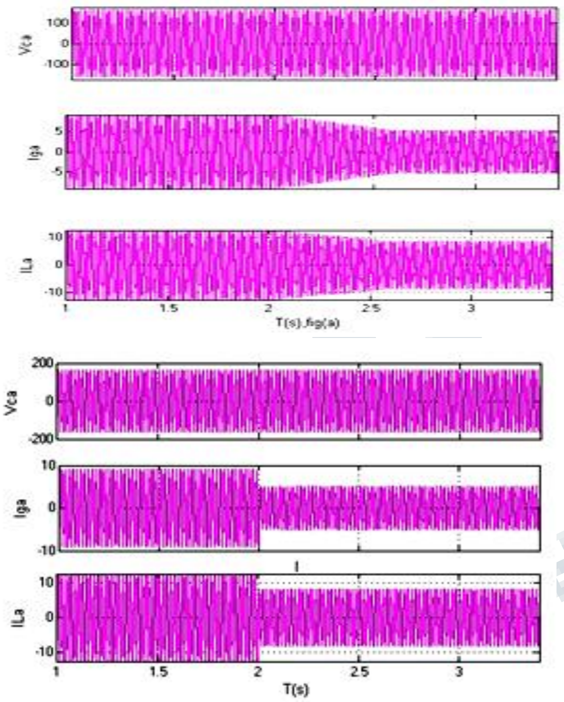
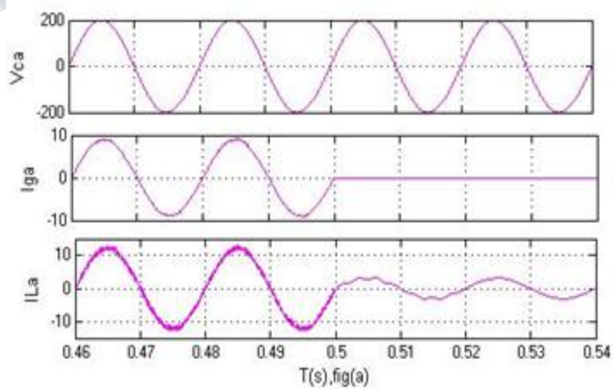


Fig. 14. Simulation waveforms of load voltage v_{Ca}, grid current i_{ga}, and inductor current i_{La} when DG is in the grid-tied mode under condition of the step down of the grid current reference from 9 A to 5 A with: (a) conventional voltage mode control, and (b) proposed unified control strategy.



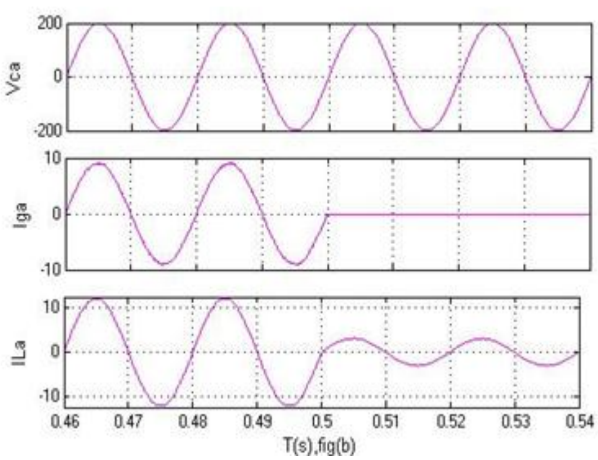
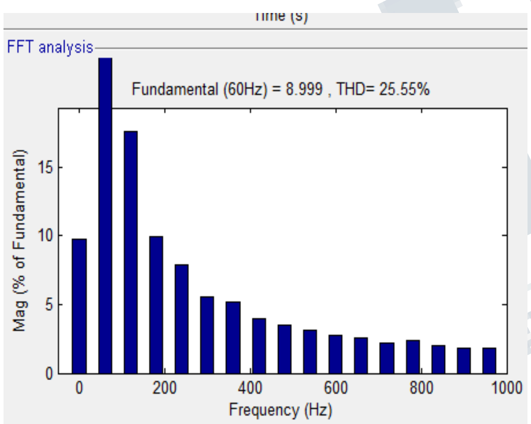
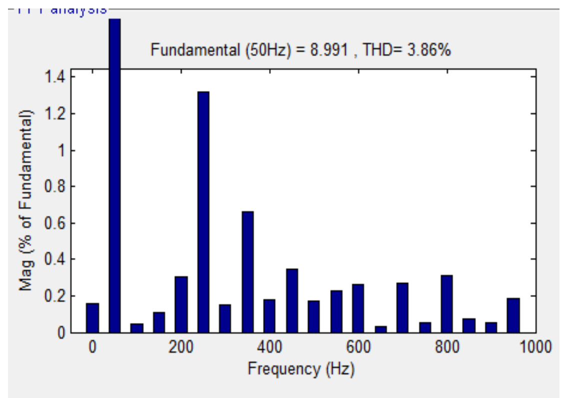


Fig. 15. Simulation waveforms of load voltage v_{Ca}, grid current i_{ga}, and inductor current i_{La} when DG is transferred from the grid-tied mode to the islanded mode with: (a) conventional hybrid voltage and current mode control, and (b) proposed unified control strategy.

FFT Analysis





Fig(b)

THD analysis of grid current I_{ga} using with (a)PI-controller (b) FUZZY-controller

VI. CONCLUSION

There is no required for switching between two different control architectures or critical island detection by using a unified controller strategy was *proposed for* 3- *φ* inverter in DG to operate in two modes. *The DG operates like a current source with* fast dynamic performances in the *grid mode in this condition* a voltage control is inactivated. The voltage control preserve be mechanically activate as the utility outages occurs towards regulated the load voltage. Furthermore, a load current feed-forward connect, also it can improve the waveform worth of the loading voltage in island and grid current in grid mode. A propose unified controller strategy was confirmed with the fuzzy control simulation result

REFERENCES

1), Y. Li, D. M. Vilathgamuwaa, and P. C. Loh, "propose, real-time test analys, design and of a control for multi-user microgrid system," *IEEE Trans. Power Ele.*, vol. 19, no. 5, pp. 1195–1204, Sep. 2004

2) .F. Gao and M. R. Iravani, "A control strategy for a DG unit in independent and grid-connected modes of operation," *IEEE Trans. Power Del.*, vol. 23, no. 2, pp. 850–859, Apr. 2008

3) S.-H. Hu, C.-Y. Kuo, T.-L. Lee, and J. M. Guerrero, "Droop control inverters by seamless transition between

grid connected and island operations modes," in *Proc. 3rd IEEE Energy Convers. Congr. Expo.*, Phoenix, AZ, USA, 2011.

4) Y. A. R. I. Mohamed, H. H. Zeineldin, M. M. A. Salama, and R. R. Seethapathy, "Seamless formation and robust control of distributed generation microgrids via direct voltage control and optimized dynamic power sharing," *IEEE Trans. Power Electron.*, vol. 27, no. 3, pp. 1283– 1294, Mar. 2012.

5) R. Tirumala, N. Mohan, and C. Henze, "Seamless transfer of grid-connected PWM inverters between utility-interactive mode in standalone mode,and grid-connected" in *Proc. 17th IEEE Power Ele. Conf. Expo.*, Dallas, TX, USA, 2002, pp. 1081–1086.

6) I. J. Balaguer, Q. Lei, S. Yang, U. Supatti, and F. Z. Peng, "Controller for and intentional islanded operations of distributed power generation," *IEEE Trans. Ind. Electron.*, volu. 58, no. 1, Jan. 2011.

7). D. N. Gaonkar, G. N. Pillai, and R. N. Patel, "Seamless transfer of micro-turbine generation system operation between grid-connected mode and islanding modes," *Electr. Power Compon. Syst.*, vol. 37, no. 2, Jan. 2009.

8). T.-S. Hwaang and S..Y. Park, "a seamless controller strategy of distribution generation inverter for critical load safety in strict grid disturbances," in *Proc. 27th IEEE. Power- Electron. Conf. Expo.*, Orlando, FL, USA, 2012,

9). D. Dong, T. Thacker, R. Burgos, D. Boroyevich, F. Wang, and B. Giewont, "Controller design and experimental verification of a multi function single phase bidirectional PWM converter for nonconventional energy systems," in *Proc. 13th Eur. Conf. Power Electron. Appl.*, Barceloona, Spain, 2009.